Auroral computed tomography method and its application to discrete aurora

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Aurora computed tomography (ACT) is a method to reconstruct spatial and energetic distributions of precipitating electrons from auroral monochromatic images simultaneously taken by multiple imagers. We have developed the ACT method and have demonstrated that it is useful to extract the spatiotemporal variation of the energy of precipitating electrons for discrete aurora (Tanaka et al., 2011). We present the ACT method and the analysis results by applying it to several auroral events. The analysis flow is summarized as follows: (1) Geometric camera calibration to determine the direction of each pixel by using night sky images with stars. (2) Determination of the parameters for the reconstruction, such as the area of reconstruction region, the size and number of grid, and the number of iteration. (3) Determination of the hyper-parameters, such as the weighting factor for each image and the relative calibration factors among multiple imagers by the cross-validation analysis. (4) Calculation of the 3D distribution of volume emission rate by solving the inverse problem. (5) Calculation of the energy distribution of precipitating electrons, the 3D distribution of the ionospheric electron density, and the height-integrated ionospheric conductivity by using theoretical and empirical models. The inverse problem was based on the Bayesian model and was formulated as a problem of maximization of posterior probability and the Gauss-Newton algorithm was adopted to solve the inverse problem. We show the results of the tomographic inversion analysis of several discrete aurora events.

References

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